

Transitioning the North American Land Data Assimilation System (NLDAS) into NCEP Operations

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Outline

- **Motivation**
- **NLDAS Overview**
- **Background**
- **Components**
- **Products**
- **Future**

Motivation: Hydrometeorological Extremes: Drought



*Meteorological:
Precipitation*



*Agricultural:
Soil moisture*



*Hydrological:
Streamflow*

Drought

From Wikipedia, the free encyclopedia

For other uses, see [Drought \(disambiguation\)](#).

Drought is an extended period when a region receives a deficiency in its water supply, whether atmospheric, [surface](#) or [ground water](#). A drought can last for months or years, or may be declared after as few as 15 days.^[1] Generally, this occurs when a region receives consistently below average [precipitation](#). It can have a substantial impact on the [ecosystem](#) and [agriculture](#) of the affected region. Although droughts can persist for several years, even a short, intense drought can cause significant damage^[2] and harm to the local [economy](#).^[3] Prolonged droughts have caused [mass migrations](#) and humanitarian crises.

Motivation: Hydrometeorological Extremes: Flood



Flood

2013 Colorado Flooding



Flash Flood

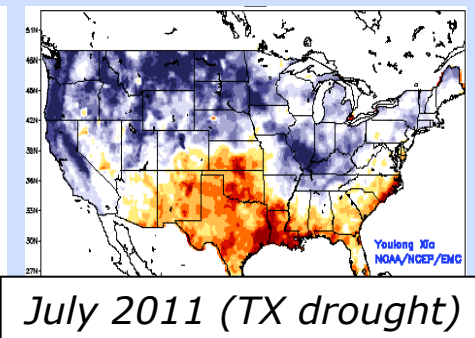
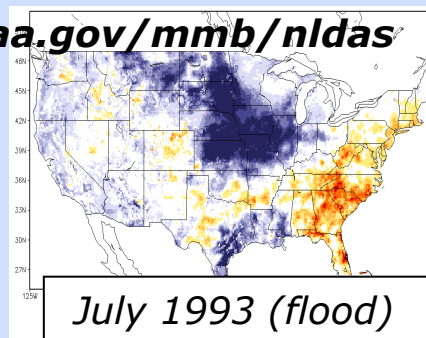
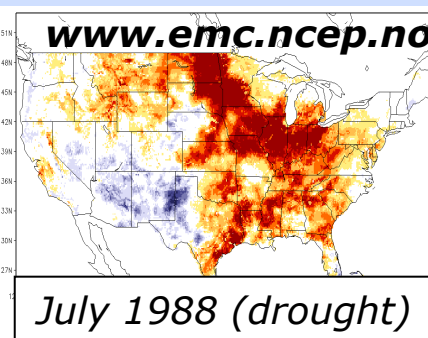
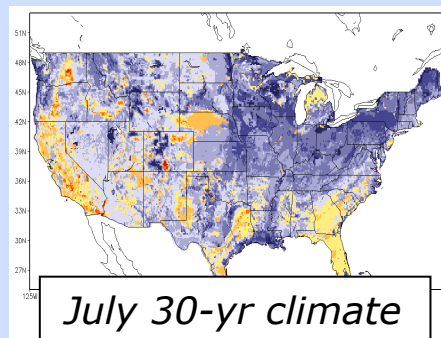
From Wikipedia, the free encyclopedia

For other uses, see [Flood \(disambiguation\)](#).

A **flood** is an overflow of water that submerges land which is usually dry.^[1] The [European Union \(EU\) Floods Directive](#) defines a flood as a covering by [water](#) of land not normally covered by water.^[2] In the sense of "flowing water", the word may also be applied to the inflow of the [tide](#). Flooding may occur as an overflow of water from water bodies, such as a [river](#) or [lake](#), in which the water overtops or breaks [levees](#), resulting in some of that water escaping its usual boundaries,^[3] or it may occur due to an accumulation of rainwater on saturated ground in an areal flood. While the size of a lake or other body of water will vary with seasonal changes in [precipitation](#) and snow melt, these changes in size are unlikely to be considered significant unless they flood [property](#) or drown [domestic animals](#).

Overview: North American Land Data Assimilation System (NLDAS)

- Land models: Noah, SAC, VIC, Mosaic run in “uncoupled” mode.
- Forcing: NCEP Climate Prediction Center obs precip (gauge-based, radar/satellite disaggregated), and atmospheric forcing from NCEP North American *Regional Climate Data Assimilation System*. Output: 1/8-deg. land & soil states, surface fluxes, runoff/streamflow.
- Climatology from land model assimilation runs for 30+ years provide **anomalies** used for **drought monitoring**; supports USDM, NIDIS etc.
- **Operational at NCEP 05 Aug 2014.**
- Research supported by NOAA Climate Program Office for NLDAS partners: NASA/GSFC, NWS Office of Hydro. Develop., Princeton Univ., Univ. Washington.



NLDAS four-model ensemble monthly soil moisture anomaly

NLDAS Background: Partners

- **NLDAS, Data Sets, Land Model Development:**

M. Ek, Y. Xia, H. Wei, J. Dong, J. Meng (NCEP/EMC)
J. Sheffield, E. Wood et al (Princeton U.)
D. Mocko, C. Peters-Lidard (NASA/GSFC)
V. Koren, B. Cosgrove (NWS/OHD)
D. Lettenmaier et al (U. Washington)
L. Luo (U. Michigan, formerly Princeton)
Z.-L. Yang et al (UT-Austin); F. Chen et al (NCAR), etc.

- **NLDAS Maintenance and Operational Transition:**

Y. Xia (NCEP/EMC land group), Yuqiu Zhu (NCEP/EMC), Simon Hsiao and others (NCO)

- **NLDAS Products Application:**

K. Mo (NCEP/CPC)
M. Rosencrans (CPC), Eric Luebehusen (USDA), U.S. Drought Monitor (USDM) Author Group, and National Integrated Drought Information System (NIDIS).

- **Support:**

NOAA Climate Program Office: MAPP (currently) and previous programs

NLDAS Background: History

- Multi-agency/institute collaboration.
- Long-term Research effort (pre-2000 to 2014).
- Multi-grant support: NOAA Office of Global Programs, Climate Program Office, under GCIP, GAPP, CPPA, and MAPP projects, and NASA/ Terrestrial Hydro Program
- Supported Research-to-Operation work (R2O)
- **Connections to Climate Test Bed (CTB), Hydrometeorological Testbed (HMT)**

Land Surface Observation, Modeling and Data Assimilation

[< Previous Chapter](#)

Overview of the North American Land Data Assimilation System (NLDAS)

[Next Chapter >](#)

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PDF (4,857 KB)

Youlong Xia, Brian A. Cosgrove, Michael B. Ek, Justin Sheffield, Lifeng Luo, Eric F. Wood, Kingtse Mo, and NDLAS team (2013)
Overview of the North American Land Data Assimilation System (NLDAS). Land Surface Observation, Modeling and Data Assimilation: pp. 337-377.

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Part 4: Application

Overview of the North American Land Data Assimilation System (NLDAS)

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NLDAS Components: Land Models

Atmospheric Community

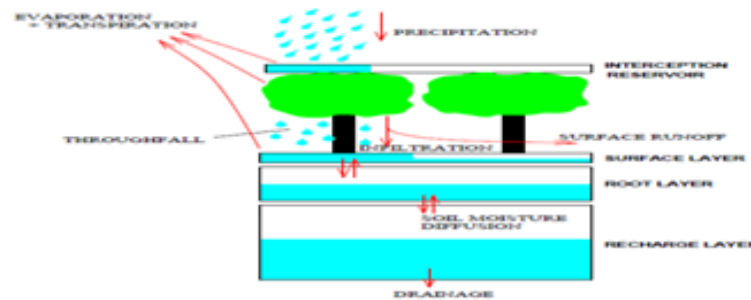
Operational Models



Noah

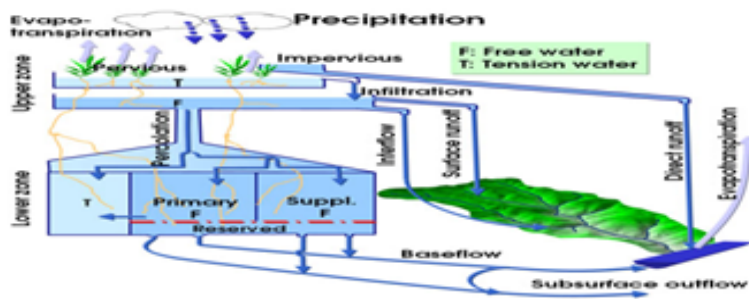
**NCEP operational
land model**

Hydrology Community



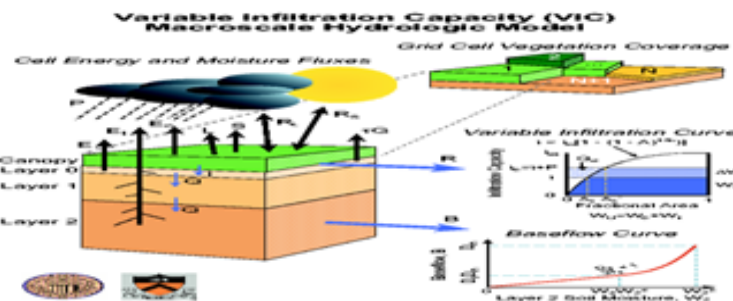
Mosaic

NASA GSFC



SAC

**NWS operational
hydrological model**

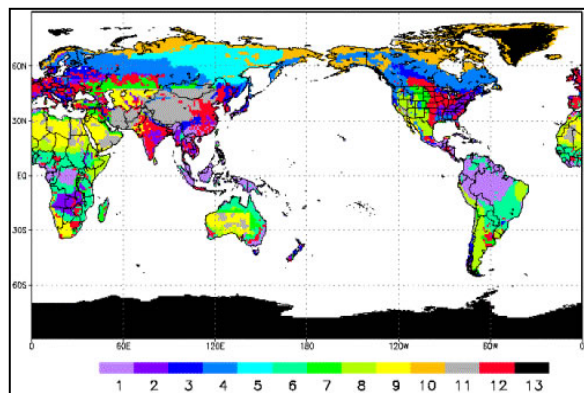


VIC

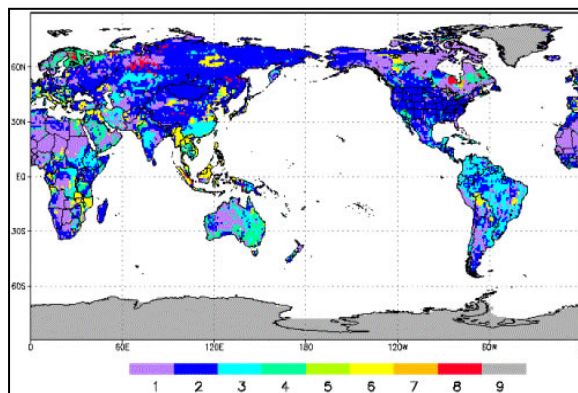
**Princeton &
U. Washington**

Research Models

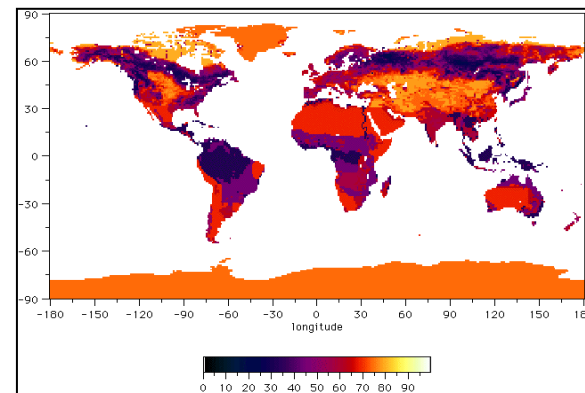
NLDAS Components: Land Data Sets



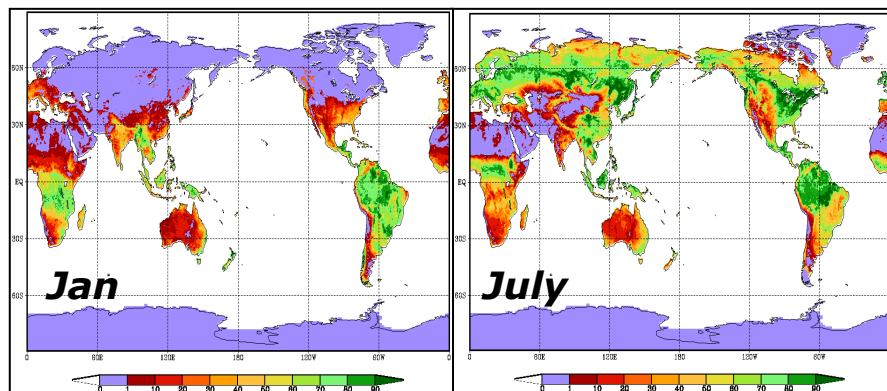
Vegetation Type
(1-deg, UMD)



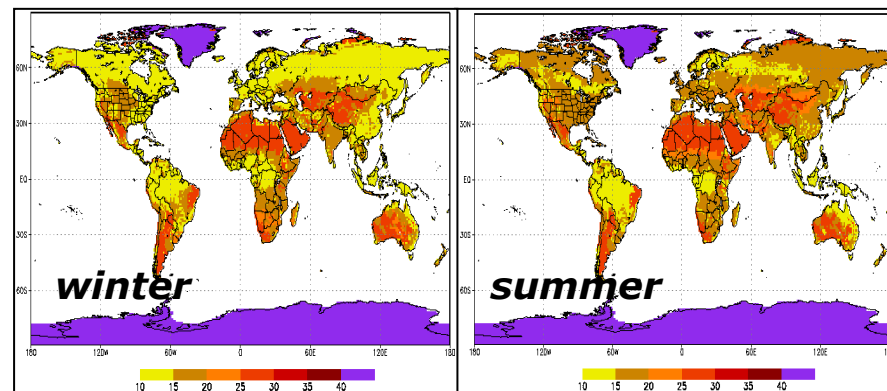
Soil Type
(1-deg, Zobler)



Max.-Snow Albedo
(1-deg, Robinson)



Green Vegetation Fraction (GVF)
(monthly, 1/8-deg, NESDIS/AVHRR)

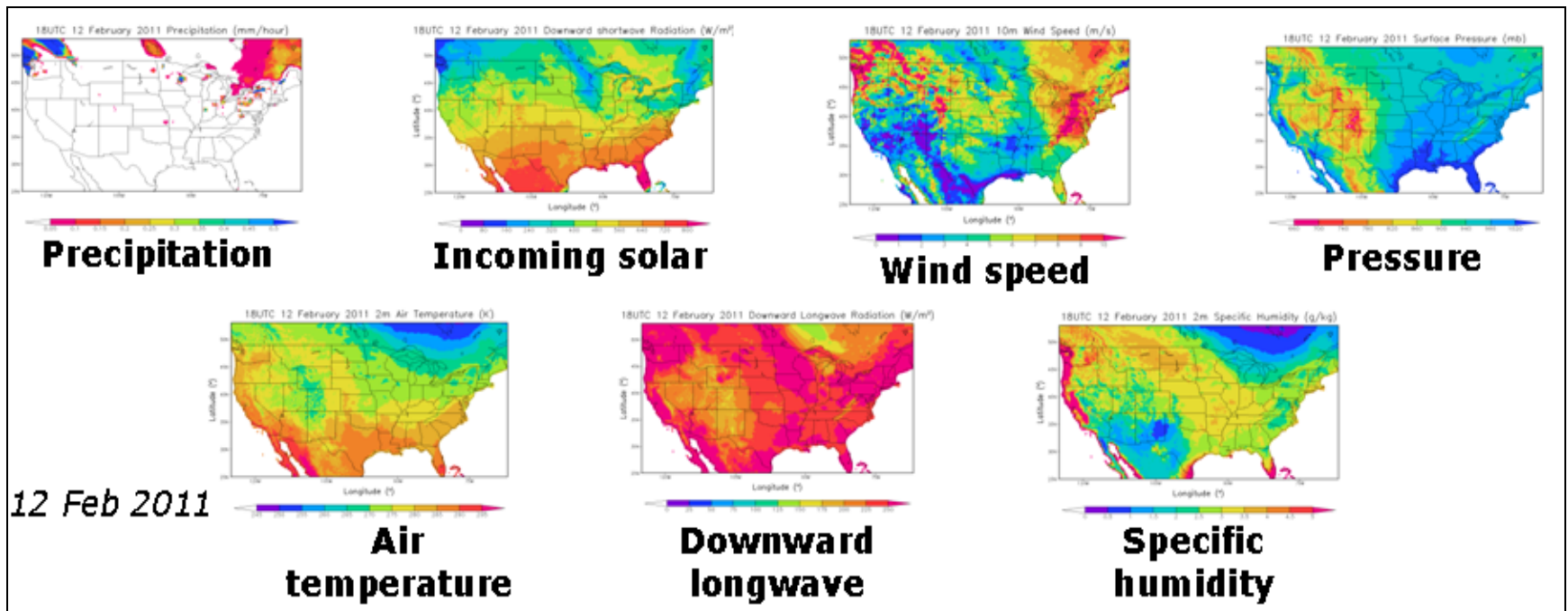


Snow-Free Albedo
(seasonal, 1-deg, Matthews)

- Fixed climatologies, or near real-time observations (e.g. GVF), some quantities to be assimilated (e.g. snow, soil moisture).

NLDAS Components: Atmospheric Forcing

- Common atmospheric forcing from Regional Climate Data Assimilation System (real time extension of the North American Regional Reanalysis, NARR) - backbone.
- CPC gauge-based observed precipitation, temporally disaggregated using radar data (stage IV), satellite data (CMORPH), bias-corrected with PRISM monthly values.
- Bias-corrected NARR solar radiation from GOES retrievals.



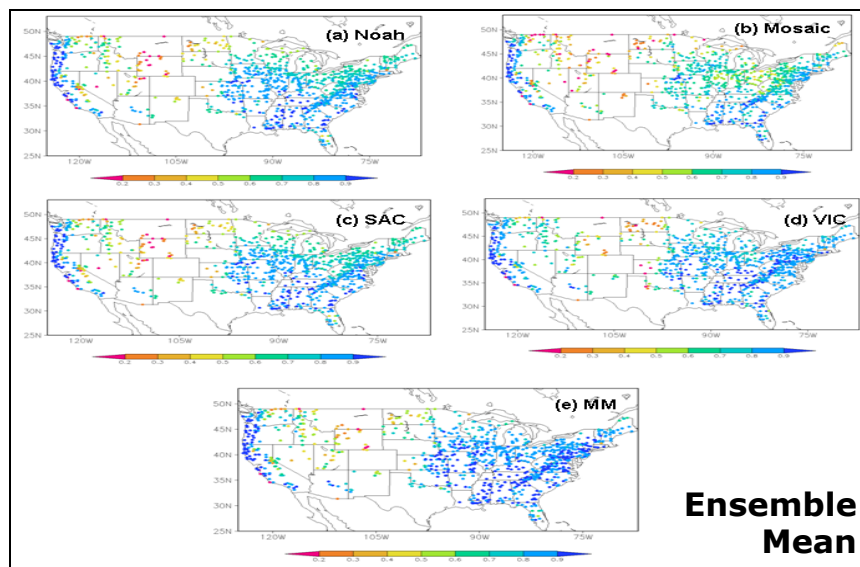
NLDAS Components: Evaluation and Validation

Comprehensive evaluation against *in situ* observations and/or remotely sensed data sets.

Energy flux validation from tower: net radiation, sensible, latent & ground heat fluxes.

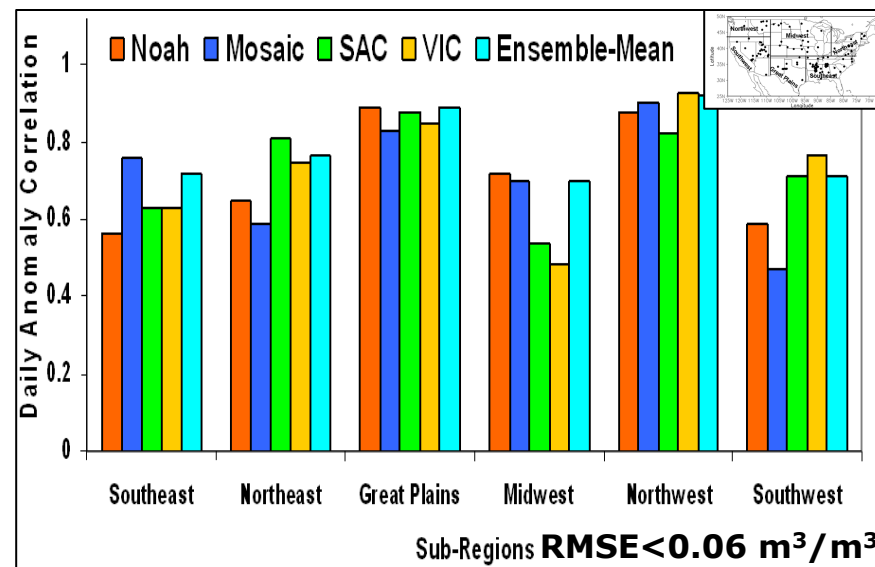
Water budget: evaporation, total runoff/streamflow.

State variables: soil moist., soil/skin temp., snow depth/cover.



Xia et al., JGR-atmosphere, 2012

**Monthly streamflow anomaly correlation
(1979-2007 USGS measured streamflow)**



Xia et al., J. Hydrol., 2014a

**Daily top 1m soil moisture anomaly
corr. (2002-2009 US SCAN Network)**

NLDAS Products: Web Sites

NLDAS Homepage - Mozilla Firefox

GES DISC Home Page — GES ...

daac.gsfc.nasa.gov

Most Visited Getting Started about:home Latest Headlines https://timesheets.ims... Customize Links https://www.google.c...

EARTHDATA Data Discovery Data Centers Community Science Disciplines

<ftp://ftp.ncep.noaa.gov/pub/data/nccf/com/nldas/prod>
<http://www.ftp.ncep.noaa.gov/data/nccf/com/nldas/prod/>
ftp://ldas.ncep.noaa.gov/nldas2/nco_nldas/

GES About

You are here: [GES DISC Home](#)

NLDAS User Statistics for calendar year 2014:

Number of distinct users: 5,437

Number of files downloaded: 44,119,161 (over 44 million)

Total volume downloaded: 93,459 Gb (over 93Tb)

Brief articles about GES DISC scientific and technical activities

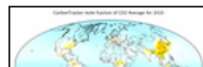


Jul 21, 2014 - [Aerosol data from SeaWiFS, 1997-2010, now available in Giovanni-4](#)
Giovanni-4 provides more analysis methods, new visualizations, and faster performance
[+ Read More...](#)

Extended articles about topics of interest to the GES DISC user community



May 14, 2014 - [April dust storm surges through China from the Taklimakan Desert](#)
2014 dust outbreak moves from the Tibetan Plateau to the Pacific coast
[+ Read More...](#)



Feb 06, 2014 - [Satellite observations of carbon dioxide: Why are they important; and what CO2 data from different NASA missions tell us](#)

Jul 15, 2014 - [New version of OMI formaldehyde data product released](#)
Formaldehyde (HCHO) in the atmosphere stems from pollution sources and biomass burning



Environmental
Modeling Center

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6th NOAA Testbeds & Proving Grounds Workshop
14-16 April 2015, Boulder, Colorado
Day 2, Advances in Environmental Intelligence – Session III, 13:20

12/16

NLDAS Products: Users

Climate Data

NLDAS: NORTH AMERICAN LAND DATA ASSIMILATION SYSTEM: MONTHLY CLIMATOLOGIES

Summary Metadata Data Access References **NCAR/UCAR**

The North American Land Data Assimilation System (NLDAS) monthly climatology data sets are broadly used by various user communities in modeling, research, and applications, such as drought and flood monitoring, watershed and water quality management, and case studies of extreme events.

North America Land Data Assimilation System (NLDAS) Daily

Request Form Results Map Chart About

[Environmental Data](#) [Dataset Documentation](#) [Data Use Restrictions](#) [How to Use WONDER](#)

Centers for Disease Control and Prevention

1. Organize table layout:

Group Results By Region **Select a temperature** Fahrenheit Celsius

And By None **And By** None **And By** None **And By** None

Select Measures (Check box to include in results. Must select at least one.)

Daily Max Air Temperature (F):
☒ Avg Temperature ☐ # of Observations ☐ Range

Daily Min Air Temperature (F):
☐ Avg Temperature ☐ # of Observations ☐ Range

Daily Max Heat Index (F):
☐ Avg Heat Index ☐ # of Observations ☐ Range

Title

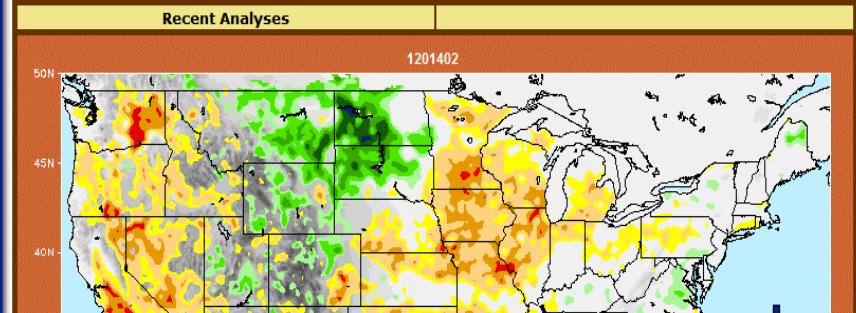
HOME > U.S. Drought > Drought Indices: Soil Moisture Percentiles

Search the CPC

Drought Indices
 • Standardized Precipitation Index (SPI)
 • Monitoring
 • Prediction
 • Verification

• Palmer Drought Severity Indices (PDSI)
 • Crop Moisture Indices
 • Soil Moisture Percentiles (based on NLDAS)
 • Standardized

Drought Indices Soil Moisture Percentiles

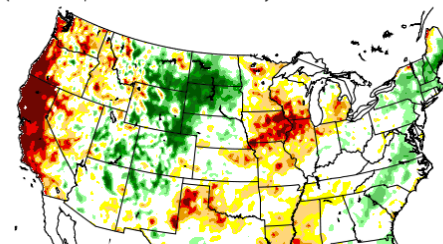


VIC Model-based Drought Condition

Move mouse over the dates on the right to see the weekly drought monitor for the last three months and the most recent forecast

Princeton University Michigan State University

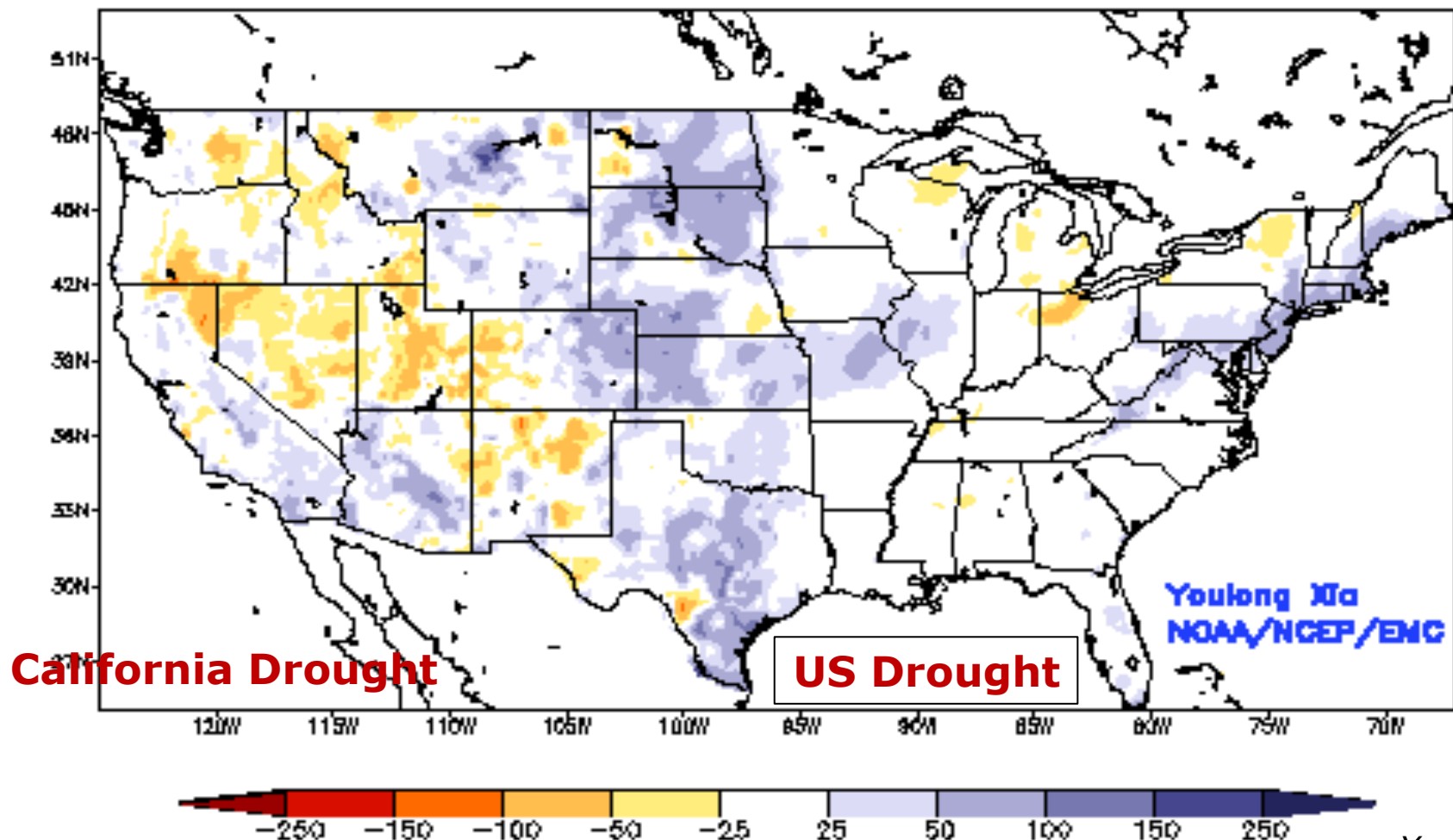
Daily Soil Moisture Percentile on 20140123
(wrt samples within a 49-day window in 1979-2011)



20140123
 20140130
 20140206
 20140213
 20140220
 20140227
 20140306
 20140313
 20140320
 20140327
 20140403 (fcst)
 20140410 (fcst)
 20140417 (fcst)
 20140424 (fcst)

NLDAS Products: Total Soil Column Soil Moisture Anomaly: March 2012 – December 2013

NCEP Noah – Past Week Total Column Soil Moisture Anomaly (mm)
Valid: MAR 02, 2010

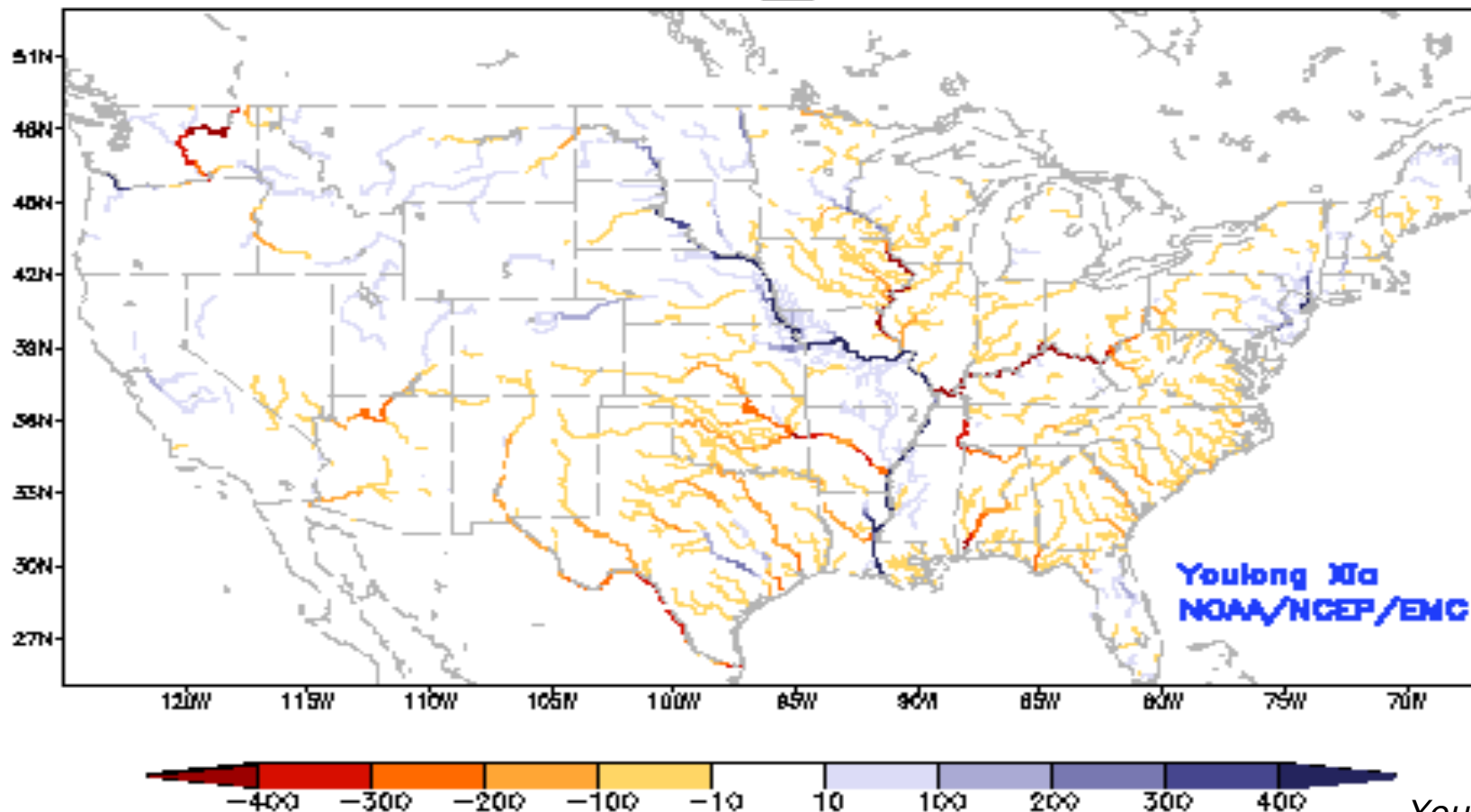


Youlong Xia

NLDAS Products: Streamflow for Hurricane Irene & Tropical Storm Lee 20 Aug – 17 Sep 2011

Ensemble mean daily streamflow anomaly (m^3/s)

Ensemble—Mean: Current Streamflow Anomaly (m^3/s)
NCEP NLDAS Products__Valid: AUG 20, 2011



Youlong Xia

Thank you!

Future

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Michael B. Ek: Michael.Ek@noaa.gov

- Extend the current NLDAS to run under NASA Land Information System (LIS) parallel environment, latest land model versions, assimil./validation tools.
- Improve/include:
 - Forcing, e.g. precipitation.
 - Land data sets, e.g. vegetation greenness.
 - Land data assimilation, i.e. snow, soil moisture.
 - Land model physics, to include vegetation dynamics, carbon, irrigation, etc.
 - Higher resolution/downscaling.
 - Enhance land model spin-up procedures
 - Products, e.g. *"Objective Blended NLDAS Drought Index"*.
- Extend domain/resolution: first North America, then global; "merge" with CFS/GLDAS.
- Provide initial land conditions for NAM, GFS, CFS.
- Earth System modeling: Include Hydro-prediction.